Royal Society, Feb. 28. *laſt: and it was found that the* Pyrmont *Waters gave a much brighter Tincture with Galls and Tea, and had a much more exalted* Chalybeat *Taſte than the* Spaw; *and a ſmall Quantity of each being kept for ſome time in Bottles, to compare them, the* Pyrmont *was found to have retained its Virtues much better than the* Spaw. *The Preſident, and ſeveral of the Members preſent, having drunk a Glaſs of it, found it of a very agreeable Reliſh, and to ſit eaſie on the Stomach.*

IV. *Remarks on the ſecond Paper in the Hiſtory of the Royal Academy of Sciences, for the Year* 1711. *concerning the Cauſe of the Variation of the Barometer: to ſhew that the Way of accounting for it in that Paper is inſufficient, and that the Experiment made uſe of to prove what is there aſſerted, does no way prove it. By* J. T. Deſaguliers, *M. A. F. R. S.*

The Paper is as follows.

'IT appears by the Barometer, that when it rains, 'or a little before Rain, the Air commonly be'comes lighter.

'That it muſt rain when the Air becomes lighter it 'is eaſie to imagine; for the imperceivable Particles of 'Water, that ſwim about in the Air in prodigious 'Quantity, not being ſufficiently ſuſtain'd when the 'Air has loſt a certain Degree of its Weight, begin to 'fall, and ſeveral of them joining together in the Fall, 'make Drops of Rain. So when about half of the 'Air is drawn out of the Recipient of the Air-Pump,

'(and

'(and conſequently the remaining Air is as weak again as at firſt) ſomething like a ſmall Rain falls. But why ſhou'd the Air become lighter? One might imagine that in the Place where it rains, it may have loſt ſome of its Weight and Bulk, by means of the Winds carrying away ſome Part of it: but Monſieur *Leibnitz*, in a Letter to the Abbot *Bignon*, gives a more ingenious and more new Reaſon for it.

'He pretends that a Body, which is in a Liquid, weighs with that Liquid, and makes up part of its whole Weight, ſo long as it is ſuſtained in it; but if it ceaſes to be ſuſtain'd, and conſequently falls, its Weight no longer makes a Part of the Weight of the Liquid, which thereby comes to weigh leſs. This may naturally be applied to the abovementioned Particles of Water; they encreaſe the Weight of the Air when it ſuſtains them, which is diminiſhed when it lets them fall: and as it may often happen that the Particles of Water that are higheſt, fall a conſiderable time before they join with thoſe that are low, the Gravity of the Air diminiſhes before it rains, and the Barometer ſhews it.

'This new Principle of Monſieur *Leibnitz* is ſurprizing. For muſt not a ſtrange Body, whether ſuſtained in a Liquid or not, always weigh? Can it gravitate upon any other bottom than that which ſuſtains the whole Liquor? Does that Bottom ceaſe to carry a ſtrange Body, becauſe it falls? And is not that Body all the while it is falling, part of the ſaid Liquid as to the Weight? At that rate, whilſt a Chymical Precipitation is made, the whole Matter ought to weigh leſs, which has never been obſerved, and ſcarce appears credible.

'Notwithſtanding theſe Objections the Principle holds good, when more cloſely examin'd. What ſu-

'ſtains

'ſtains a heavy Body is preſs'd by it. A Table, for Example, which ſuſtains a Pound Weight of Iron, is preſſed by it, and is ſo only becauſe it ſuſtains the whole Action and Effect of the Cauſe of Gravity, (whatever it be) to puſh that Lump of Iron lower. If the Table ſhou'd yield to the Action of that Cauſe of the Weight (or Gravity) it would not be preſs'd, and therefore would carry nothing. After the ſame manner the Bottom of a Veſſel, which contains a Liquid, oppoſes it ſelf to all the Action of the Cauſe of Gravity againſt the ſaid Liquid: If a ſtrange Body ſwims in it, the bottom oppoſes it ſelf alſo to the ſaid Action againſt that Body, which, being in *Æquilibrio* with the Liquid, is in that reſpect really a Part of it. Thus the Bottom is preſs'd both by the Liquid and the ſtrange Body, and ſuſtains them both. But if the body falls, it yields to the Action of Gravity, and conſequently the Bottom does no longer ſuſtain it; neither will it ſuſtain it, till the ſaid Body is come down to the Bottom. Therefore during the whole Time of the Fall, the Bottom is eaſed of the Weight of that Body, which is no longer ſuſtain'd by any thing, but puſh'd down by the Cauſe of Gravity, to which nothing hinders it from yielding.

' Monſieur *Leibnitz*, to confirm his Notion, propoſed an Experiment. He ſays, that two Bodies muſt be tied to the two Ends of a Thread, the one heavier, and the other lighter than Water, yet ſuch as both together may ſwim in Water: Put them into a Tube full of Water, the Tube being tied to one End of the Beam of a Ballance whoſe other End has a contrepoiſing Weight: Then if we cut the Thread which ties the Bodies together (that are of unequal Weight) ſo that the heavieſt may preſently deſcend. He ſays, that in ſuch a Caſe the Tube would be no longer in *Æquibrio*, but its counterpoiſing Weight wou'd preponderate

'rate, becauſe the Bottom of the Tube wou'd be leſs 'preſs'd. It is plain, that the Tube muſt be ſufficiently 'long, that the falling Body may not reach the bot'tom before the Tube has time to riſe. In Chymical 'Precipitations, the Veſſels are either too ſhort, or 'what is precipitated falls ſometimes too faſt and 'ſometimes too ſlow; for then the little Bodies are 'always (as to Senſe) *in Æquilibrio* with the Liquor 'that contains them.

'Monſieur *Ramazzini*, the famous Profeſſor at *Padua*, 'to whom Monſieur *Leibnitz* had propoſed his Expe'riment, has made it with Succeſs, after ſome fruitleſs 'Trials. Monſieur *Reaumur* (to whom the Academy 'had recommended it) has alſo made it with Succeſs: 'This is a new View in Natural Philoſophy, which, 'tho' it depends upon a well known Principle, is very 'ſubtle and far-fetch'd; and gives us juſt Reaſon to fear 'that in Subjects that ſeem to be exhauſted, ſeveral 'things may yet eſcape us.

Remarks upon Monſieur Leibnitz's *New Principle.*

Figure 4.

LET *A B* be the Bottom of a Veſſel full of any Fluid, whoſe Top is either wider than the Bottom as *GH*, narrower as *EF*, or equal to it as *CD*. The Preſſure of the Fluid upon the Baſe *AB* will be equal to the Weight of *CB*, or of a Cylinder or Priſm of the ſame Fluid, made up of the Area of the Baſe multiplied into the perpendicular Height above it.

If the Fluid be equally denſe every way as Water, or of a Denſity uniformly diminiſh'd as you go upwards, this Propoſition (call'd by Mr. *Boyle* the Hydroſtatical

Paradox) will hold good. This is demonſtrated by all Hydroſtatical Writers.

Figure 5.

Let *EF* repreſent part of the Surface of the Earth, and *GEFH* a Pillar of the Atmoſphere, whoſe Height is *GE* the whole Height of the Air. Let us imagine the Vapours riſing out of the Earth to form themſelves into two Clouds *A* and *B*, and to ſettle in that Place where the Air is of the ſame ſpecifick Gravity with themſelves. It is evident that they will cauſe the Air to riſe ſo much higher as their Bulk amounts to, and will therefore make the Surface which was at *GH* to riſe up to *IK*, ſo that the bottom *EF* which was preſs'd by a Pillar of Air as *GEFH*, is now preſs'd by an higher Pillar as *IEFK*. Now if the Clouds *A*, *B*, by any Cauſe ſoever, change their Place, ſo as to come downwards, (for *Exemple* to *C*, *D*) the Height of the Pillar *IEFK* will remain the ſame as it was, and therefore the Bottom *EF* will be preſs'd as before: by the foregoing Propoſition.

Corollary I.

If the Clouds *A*, *B* deſcend, and in their Deſcent keep the ſame Bulk as they had before, the Surface *IK* will remain the ſame, and therefore *EF* will be preſs'd as before.

Corollary II.

Whether a Body be ſpecifically lighter or ſpecifically heavier than a Fluid; ſo long as it is detain'd in it, it will add to the Fluid as much Weight as the Weight of an equal Bulk of that Fluid: wherefore a Body does not loſe all that Weight which it added to the whole Weight

Weight of the Fluid, when it ceaſes to be ſuſtain'd in the ſaid Fluid: contrary to Monſieur *Leibnitz*'s Principle.

Scholium.

If a Cloud (by any Cauſe whatſoever) becomes ſpecifically heavier than that Part of the Air in which it ſwims, the Exceſs of its Gravity above an equal Bulk of Air will make it deſcend, and accelerate its Motion downwards; and then indeed it will loſe of its Weight by the Reſiſtance of the *Medium*, till it comes to an uniform (or ſenſibly uniform) Motion: but all the Weight that it will loſe will only be the Exceſs of its Gravity above that of the Air; for with the reſt of its Weight it will ſtill make up part of the Weight of the Air.

Experiment I. *Figure* 6.

Having with a Weight in the Scale *C* of the Balance *AB* counterpois'd the long Glaſs of Water *EI*, with a Horſe-Hair I let down the leaden Weight *W* into the Water, which from *FG* aroſe up to *EH*; and therefore the Water became heavier by the Weight of a Bulk of Water equal to the Lead. Having with another Weight in *C* made up the Counterpoiſe to the whole, with fine Sciſſars I cut the Thread of the Plummet; and all the while the Plummet was falling, the Water deſcended rather than roſe; and when the Lead was at the bottom the Water overpois'd, becauſe it had then added to it all the Exceſs of Weight of the Lead above an equal Bulk of Water, which by Experiment is about $\frac{10}{11}$ of its Weight. Had Meſſieurs *Reaumur* and *Ramazzini* tri'd the Experiment thus, the Succeſs had been the ſame; but Mr. *Ramazzini* (as I underſtood from a Gentleman who was preſent) tried it in the following Manner, as I have ſince done.

Experiment II. *Figure* 7.

Making uſe of the abovemention'd Machine, after I had balanc'd the Water and Lead in it, I fix'd to the End of the Beam *B* the Thread of the Plummet, which in the former Experiment I held in my Hand. This added to the Weight hanging at *B*, and oblig'd me to put into the other Scale a Weight equal to $\frac{10}{11}$ of the Lead, to recover the *Æquilibrium*. Then cutting the Thread or Hair, the Scale with the Weights overpois'd whilſt the Lead was falling; but the *Æquilibrium* was reſtor'd when it came to the Bottom. So that the Lead even then muſt have loſt only its Exceſs of Weight above Water.

Experiment III. *Figure* 8.

I tried the Way propoſed by Monſieur *Leibnitz* in the following Manner.

I took a Cork *C* weighing an Ounce, and ſomething more than four times lighter than an equal Bulk of Water, and a Ball of Antimony *W* about four times ſpecifically heavier than Water, and of four Ounces Weight. The Cork laid upon the Water in the Veſſel *EABD* rais'd the Water from *SS* to *GG*, and added an Ounce to the Weight of the whole Water: then ſuſpending the Ball of Antimony by a String, and letting it hang in the Water at *N*, it rais'd the Water from *GG* to *HH*, and ſo added another Ounce to the Weight of the Water. Then tying the Antimony to the Cork (See the Figure of the Veſſel mark'd with little Letters) the Cork had added to it three Quarters of the Weight of the Antimony which the Hand before had ſuſtain'd, and made it ſink ſo as to be almoſt cover'd, and raiſed the Water to *ik*, adding three Ounces to its Weight. Hanging this Veſſel of Water upon the Balance, and a Coun-

Counterpoiſe at the other End, upon cutting the String the Veſſel of Water was rais'd up, and the *Æquilibrium* was not reſtor'd till the Antimony came to the Bottom.

By obſerving that as the Cork (being freed from the Weight of the Antimony) aroſe, and that during the Fall of the Body, the Water ſunk to *h h*, it appears that this is, in effect, the ſame Experiment as the former, and concludes no more. As to the real Cauſe of the Variation of the Barometer, namely, the Accumulation of the Air by Winds over the Place where the Barometer riſes; and part of the Air being blown away where the Mercury in the Barometer ſinks, ſee Doctor *Halley*'s Account of it in the *Phil. Tranſactions.* Numb. 181.

POSTSCRIPT.

IN making the firſt Experiment before the R. Society, of a Piece of Lead ſuſpended by a Thread, whilſt it was wholly cover'd with Water in the large Tube in which it hung (whoſe Length was 4 Feet) it was obſervable, not only that the End of the Balance (to which the Tube of Water with the Lead in it was fixed) did not riſe, when the Thread was cut, (to let the Lead fall from the Top to the Bottom of the Tube) as it muſt have done according to Mr *Leibnitz*'s Principle; but that the ſaid End of the Balance began to deſcend from the Time that the Lead began to fall. Therefore to be ſure that it was not the Plummets rubbing againſt the Sides of the Tube in its Fall, which cauſed that *phænomenon*, I hung to the Balance a long Glaſs of three Inches diameter inſtead of the Tube, and making the Experiment as before, it ſucceeded in

the

the ſame manner: the End of the Balance which carried the Veſſel of Water ſunk as ſoon as the Thread of the Plummet was cut; tho' this Glaſs was not above half ſo long as the Tube.

When by holding the String I drew the Lead upwards and downwards in the Water, there was no ſenſible Alteration of the *Æquilibrium.* Neither was it alter'd by cutting the String of a Stone-Plummet, becauſe of the Shortneſs of the Glaſs, and the little Exceſs of ſpecifick Gravity in the Stone: for the greater the Difference is betwixt the Body made uſe of in this Experiment and Water, as well as the bigger the Body it ſelf is, the better the Experiment will ſucceed.

Hence it appears, that when a Body, ſpecifically heavier than a Fluid, is (by what cauſe ſoever) detain'd in any Place of the ſaid Fluid, it adds as much to the Weight of the whole Fluid as an equal Bulk of the ſaid Fluid amounts to: And when the ſaid Body, by the Action of its Exceſs of ſpecifick Gravity above the Fluid, deſcends with an accelerated Motion; ſo long as that Motion is accelerated, the Reſiſtance of the Fluid (which is as the Square of the Velocity) takes off ſomething of the whole Weight of the Body; but as much as the Body loſes, ſo much the Water gains, over and above what was given it by its riſing on Account of the immers'd Body.

A Body therefore that falls in a Fluid is ſo far from making the Fluid lighter as it falls, that it makes it preſs more upon the Bottom that ſuſtains it, when it is falling, than when it was at reſt in the Fluid.

If the Veſſel of Water be long enough for the falling Body to come to an uniform Motion before it reaches the bottom, the Force impreſs'd on the Water under the Body will make it preſs the Bottom, as much as if the Body were actually at bottom; the Body in that Caſe loſing

ſing all its Exceſs of Gravity above that of the Water, and the Water gaining it.

Hence it follows, that a falling Cloud, when it comes to an uniform Motion, will not only add to the Weight of the Air as much as the Weight of an equal Bulk of Air; but even as much as its whole Weight amounts to, tho' it be ſpecifically heavier than the Air about it.

All the Diminution of Weight that can be allow'd in this Caſe is this. If we imagine the Air to have a ſmooth, regular Surface, as we have at firſt ſuppos'd, (or if that be not allow'd, we may take any imaginary Surface of it above the Clouds) when a falling Cloud is diminiſh'd in Bulk, (as when it is chang'd into Rain) the Surface of the Air will ſubſide in proportion to that diminution, and therefore will weigh leſs, by ſo much as is the Weight of a Quantity of Air equal to the Bulk that Cloud has loſt: But when the Drops of Rain after their Acceleration (occaſion'd by their Exceſs of Gravity above that of the Air) are come to an uniform Motion by the Reſiſtance of the Air, they reſtore to the Air the Weight that it had loſt. Now this uniform Motion being acquir'd in about two Seconds of Time, and the Diminution of Gravity in the Air being inſenſible, when compared to near three Inches of Mercury (for ſuch is the Variation of the Barometer with us) can no way be the Occaſion of thoſe ſo ſenſible Alterations in it, which happen ſome time before Rain or Fair Weather.

Add to this that the whole Quantity of Rain that falls in England *and* France, *in the Space of one Year, ſcarce ever equals two Inches of* Mercury: *And in moſt Places between the* Tropicks, *the Rains fall, at certain Seaſons, in very great Quantities, and yet the* Barometer *ſhews there very little or no Alteration.*

Fig. 6.

Fig. 7.

Fig: 5

Fig 1.

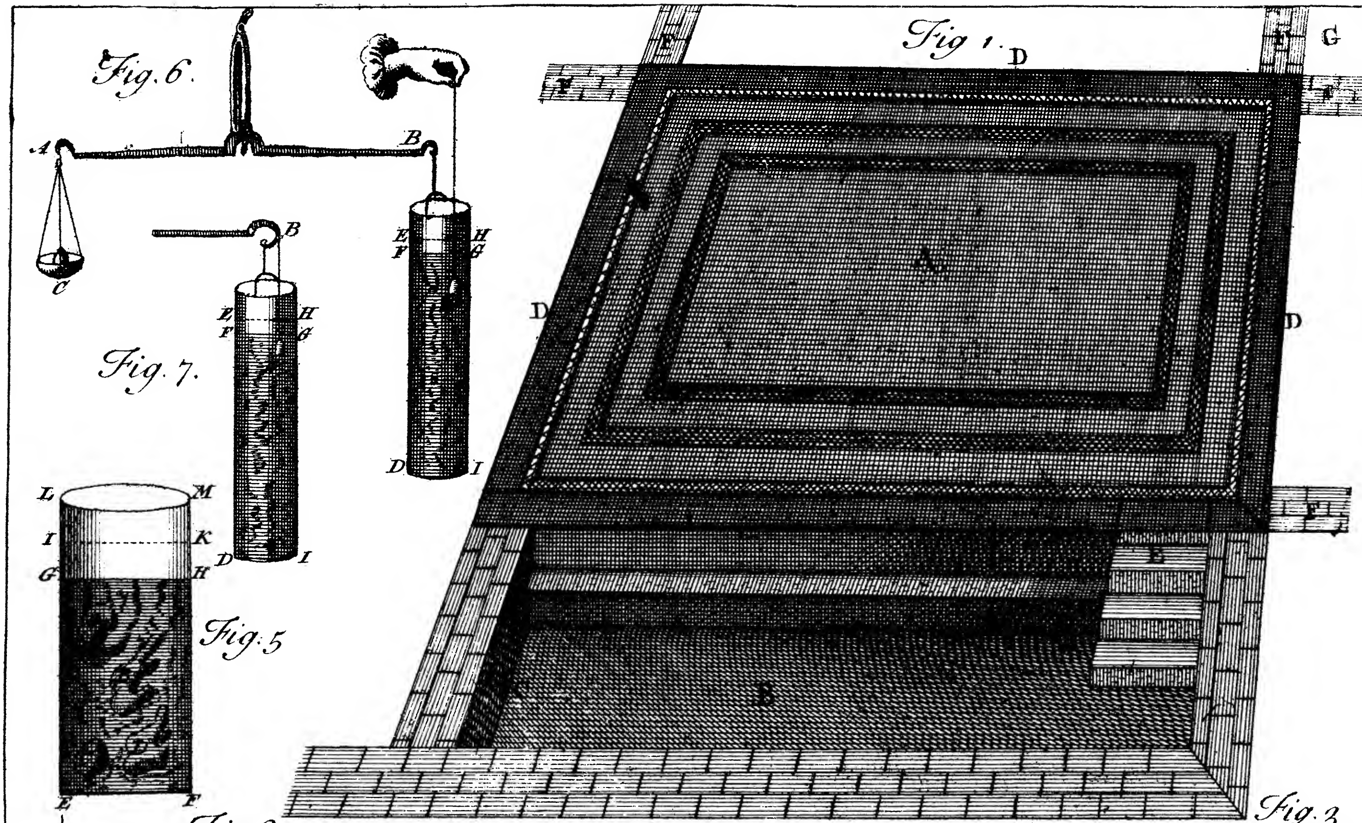


Fig. 8.

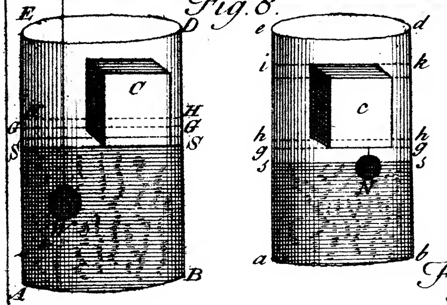


Fig. 4.

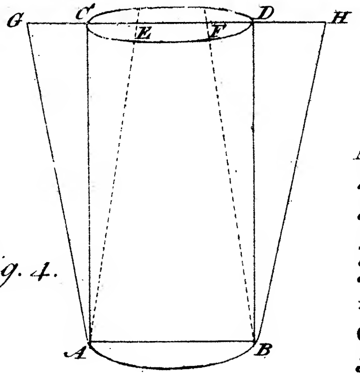


Fig. 2.

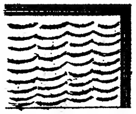
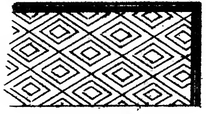


Fig. 3



A The Pavement. B The Bath. C. The Sink and the other Paſsage through the Wall at the Eaſt end of the Bath. D The Roman Brick w^{ch} bounded the Pavement, laid flat and covered with Terraſs. F. Foundations continu'd ſeveral ways. E. The Landing place out of the Bath. G. The corner of a large ſpace pav'd wth Roman Brick, and cover'd with Aſhes, Coals, &c.

Philoſoph. Tranſact. N.° 351.